valvular orifice, called the stomach-mouth, a construction which "permits the bee to eat when, where, and how she pleases, without having to trouble her mouth in any way." And this strange power extends even to the respiratory process, one or two rapid breaths so charging the tracheæ, that for the next three minutes no further inhalation is required. One singularly interesting belief is shattered by Mr. Cowan—that the accuracy of comb structure is due to "mathematical instinct." The story of Maraldi's measurements and of Kœnig's miscalculations, of the error in a book of logarithms discovered by the exquisite precision of bee mensuration in constructing the lozenge-shaped plates which form the basis of the cells, has been popularized by many writers. Mr. Cowan's observations show that in no carefully measured piece of comb are all the diameters of the different cells or all the angles of the different plates identical, nor is their variation regular. Cells are sometimes square, sometimes acute-angled, sometimes roughly circular. The mechanical purpose of the bees is confined to the formation of a cylinder, but the mutual interference of the little architects, as in the case of impinging soap-bubbles or bottled peas, compels the hexagonal form.

Though shorn of its mathematical attributes, bee intelligence remains extraordinary. Their prescience, their power of exact mutual communication, the elaborate community of discipline and labour which characterize each colony, throw doubt on the familiar distinction which denies to lower animals the analytic faculty—accords perception to the bee or dog, conception to the human mind alone. Into this question Mr. Cowan does not enter; but we are not surprised to learn from him that the well-defined brain necessary to the possession of intelligence forms in the bee 1/174 part of the volume of the body, sinking in other insects as low as to the 1/4200 part.

The muscular power of the bee is as much in advance of man's as its intellectual power is inferior. A man's power of traction is far below the weight of his body; a bee can draw twenty times its own weight. Its flight exceeds twelve miles an hour, and it will go four miles in search of food. Its wings, braced together in flight by a row of hooklets, bear it forward or backward, with upward, downward, or suddenly arrested course, by a beautiful mechanical adaptation which the author admirably describes. Its voice-organs are three-fold, the vibrating wings, the vibrating rings of the abdomen, and a true vocal apparatus in the breathing aperture or spiracle: the first two produce the buzz; while the hum—surly, cheerful, or colloquially significant—is due to the vocal membrane. Some of its notes have been interpreted. "Huumm" is the cry of contentment; "Wuh-wuh-wuh" glorifies the incessant accouchements of the queen; "Shu-u-u" is the frolic note of young bees at play; "Ssss" means the muster of a swarm; "Brrr" the slaughter or expulsion of the drones; the "Tu-tu-tu" of newly-hatched young queens is answered by the "Qua-qua-qua" of the queens still imprisoned in their cells.

Enough has been said to indicate the interest and value of this compendium. For the description of the tongue, with its rod, spoon, tasting-hairs; of the pulvillus and its adhesive secretions; of the marvellous changes developed in the later metamorphosis of the imperfect insect; of the compound eyes with their mosaic vision, incapable, we suppose, through deficient muscular adjustment (though on this point Mr. Cowan is silent) of delineating to the bee mind a perceptual world resembling ours; of the sting and poison sac, of the wax pockets with their secreted scales, drawn out by the hind leg pincers, made malleable by mastication and saliva, kneaded into foundation walls and cells—the student must betake himself to the book. Full of matter as it is, it leaves much unsettled. The character of the sensory functions, the existence of gustatory and olfactory organs, the meaning of various unintelligible bodies in the antennæ, abdomen, labium, ligula, have not been determined—may perhaps never be understood; for "it is not impossible that insects may possess senses or sensations, of which we can no more form an idea than we should be able to conceive red or green if the human race were blind."

For the second edition of the book, which will doubtless be demanded, certain minor corrections or amendments may be suggested. If bees are *Hymenoptera*, the Greek word for a membrane (p. 2) may fairly be written hymen. In p. 12, ll. 15, 16; in p. 63, ll. 4-9; p. 102, l. 29, slight textual improvements are desirable. Near the bottom of p. 26 is an obvious printer's error. On p. 64, l. 11, the word "those" is not readily referable to the ganglia for which it presumably stands. The engraving on p. 25 is repeated on p. 96. The description of the brain, pp. 68, 69, is indistinct in places, and would gain if the illustrations, 31, 32, were lettered. So, again, the inversion of the male organ, pp. 129, 130, is not clear from Fig. 53. And is it impertinent to hope that the peroration may be re-written or struck out? By all means recognize formally, if it has not indeed been all along assumed, the benevolence and wisdom of a superintending Providence; but the pious platitudes of pp. 190-192 are an anti-climax to the clear reasoning and precise statement which are maintained throughout the scientific portion of the work, and leave on the critical palate an after-taste less sweet than honey to the mouth.

W. Tuckwell.

ELECTRO-METALLURGY.

The Electro-plater's Hand-book. By G. E. Bonney. (London: Whittaker and Co., 1891.)

THIS book is designated as being a "practical manual for amateurs and young students in electro-metallurgy," and intended "to meet the wants of amateurs and young workmen desiring a practical manual in electro-plating at a low price."

It contains a large amount of sound information respecting the details of preparing metals for electro-plating; the processes of cleaning, polishing, scratch-brushing, &c.; a number of useful practical tables; numerous recipes for making plating solutions; descriptions of workshop appliances, tools, pieces of apparatus, &c., of immediate practical use to a working electro-plater; and it is essentially an ordinary workman's book.

In accordance with the statement made in the preface, that "it supposes the workman to have an elementary acquaintance with electrical science," the book contains

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scarcely any information respecting the scientific principles of the art, and even Faraday's great law of definite electro-chemical action is not mentioned or explained. It will therefore be more readily purchased by the ordinary than by the superior workman, by those who prefer to work by "rule of thumb" than by those who wish to be guided by the light of science.

With regard to the statement on p. 1, that "the art of electro-metallurgy cannot be said to own an inventor," it is true that the complete art is not due to a single inventor, but it owns a series of inventors, viz. Wollaston (1801), Brugnatelli (1805), De la Rue (1836), Jacobi, Jordan, Spencer (1839), J. Wright (1840), J. Elkington (1865), &c., who were all of them prominent inventors of electro-metallurgical methods.

The rules given on p. 4 for selecting a suitable depositing solution are good, and are well known; and the remark on p. 7, that "the main consideration must be directed to current density," is a widely applicable and very useful one.

The statement on p. 8, that the current deposits the metals from solutions of alloys "in proportions determined rather by their electric equivalents than by the quantity of the metal in solution," is a very doubtful one; for instance, with copper and zinc in solution together, the electro-chemical (not "electric") equivalents of which are about equal, if the copper is in large proportion compared with the zinc, copper is deposited, and no zinc is usually deposited along with it, unless the current is of great density at the cathode.

The idea expressed on p. 12, that "the internal resistance of a battery may be reduced by using longer connecting wires between the cells," is not in accordance with the established conventional understanding that "internal resistance" is limited to the contents of the battery cells. The information given about the arrangement and construction of several kinds of voltaic batteries is full and explicit, and the same may be said about arranging their cells in series and in parallel.

With regard to the chapter on dynamos, it is a very useful one, and the longest in the book; and the construction and action of those machines are as fully described as any other part of the subject; but, whilst several good dynamos for electro-plating are mentioned and illustrated, some obsolete and wasteful ones are figured and described which might have been omitted.

Chapter vi., "Electro-plating with Silver," contains much information, both of general matters and of details useful to the working electro-plater; the statement, however, on p. 125, that the foreign salts which usually exist in a dissolved state in a cyanide of silver plating liquid "offer a resistance to the current," has never yet been demonstrated; in fact, they rather tend to diminish the resistance, and it is only when they give rise to a solid film upon the anode, and that is very rarely, when the liquid is deficient in free cyanide of potassium, that they obstruct the current.

The statement on p. 165, in the chapter on "Nickel-plating," that "very little was effected in a practical way until 1890, when Mr. Adams discovered that nickel could be deposited from a solution of the double sulphate of nickel and ammonia in a reguline condition," requires a little qualification, for both previous to and at that period the double chloride of nickel and ammonium (generally known as "Gore's solution") was rapidly extending in use in America, the early home of nickel-plating.

The chapter on "Electro-plating with Copper," is very brief. Whilst the one on "Dynamos" occupies 38 pages, and might in some respects have been abbreviated with advantage, that on "Copper" fills only 7 pages, and might have been extended.

A rather serious error in the chemistry of the subject occurs on p. 200, where the table, and the column of numbers which are really the atomic weights, are each headed "combining weights"; and the electro-chemical equivalents are headed "electric equivalents." Now, the atomic weights are in many cases very different from the combining weights, and the numbers which are there termed "electric equivalents" should have been called "electro-chemical equivalents."

Instead of employing the simple terms, made, making, stirring, &c., the author, throughout the book, continually uses the phraseology, "made up," "making up," "stirring up," "faking up" the solutions, batteries, apparatus, &c. These, however, are minor matters. The chief defect in the book is that "it supposes the workman to have an elementary acquaintance with electrical science," and, apparently on the basis of that usually fallacious assumption, omits nearly all information respecting the fundamental principles of the subject. Now we know that not only the working man, but the sons of persons in much higher grades of society, are often so incompetent to appreciate the great value to themselves of knowledge of important principles, and so anxious to obtain "quick returns" in the form of money or some easily perceived personal advantage, that they are apt to shirk learning anything which they think will not quickly yield them a profit, and this radical defect should not be encouraged by those who undertake to teach. An omission of all reference to the principles of his subject further indicates that the teacher himself either does not fully understand or adequately appreciate the foundation of the matter he professes to teach. Knowledge of the principles of his occupation is usually the point in which the workman is most deficient and most requires to be instructed.

Notwithstanding this drawback, the book is sound and good in nearly all matters of practical detail; it is also well illustrated, and may be used with advantage as supplementary to a more scientific one containing the principles of electro-metallurgy.

OUR BOOK SHELF.

Primitive Folk: Studies in Comparative Ethnology. By Élie Reclus. (London: Walter Scott, 1891.)

THIS volume belongs to the "Contemporary Science Series," edited by Mr. Havelock Ellis. It contains a popular account of the Eastern and Western Inoits, the Apaches, the Naïrs, the mountaineers of the Neilgherries, and the Kolarians of Bengal. The writer does not group his facts in accordance with any controlling idea, so that the book can hardly be said to have much continuity of interest. He writes, however, in a fresh and lively style, and has brought together many curious facts; and the work may serve as an attractive and useful introduction to the study of some aspects of ethnography. He has, of course, to describe many customs and modes of thought

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